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(56) Documents Cited
EP 0867747 A2 EP 0107757 A1 EP 0056843 A2
WO 97/48107 A1 JP 100326515 A JP 100268307 A
US 5608550 A US 4212048 A

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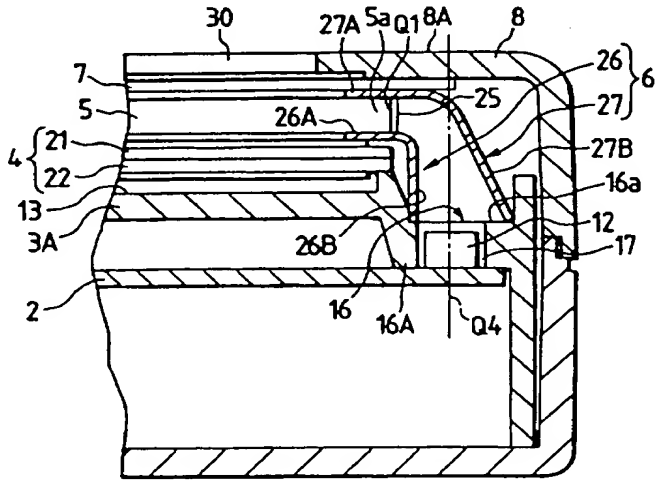
(54) Abstract Title
Front lighting means for liquid crystal display

(57) A portable electronic apparatus includes a liquid crystal panel 4 of a reflection type. A light guide member 5 operates for guiding light to the liquid crystal panel. A light source 12 operates for emitting light. There is provided a suitable device or a reflector 6 for guiding the light emitted by the light source to the light guide member. A transparent plate-shaped member 30 covers the light guide member. The transparent plate-shaped member may include a touch panel 7. The light source includes, for example, a light emitting diode, and the device optionally includes a diffusion sheet 25.

In one embodiment, the light guide member comprises a series of grooves (31, Fig 4) for reflecting light from the source towards the liquid crystal panel 4.

FIG. 3



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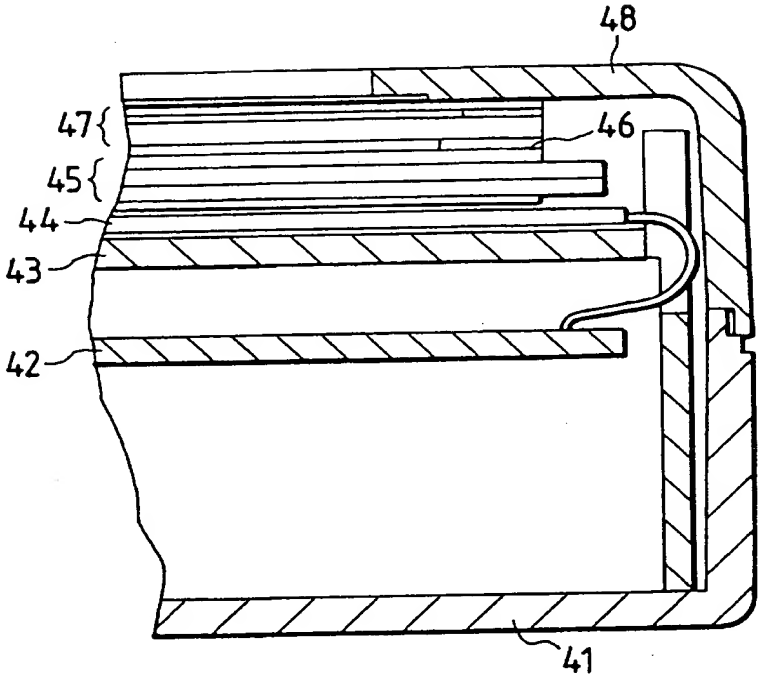
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1


48
47
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44
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42
41

FIG. 3

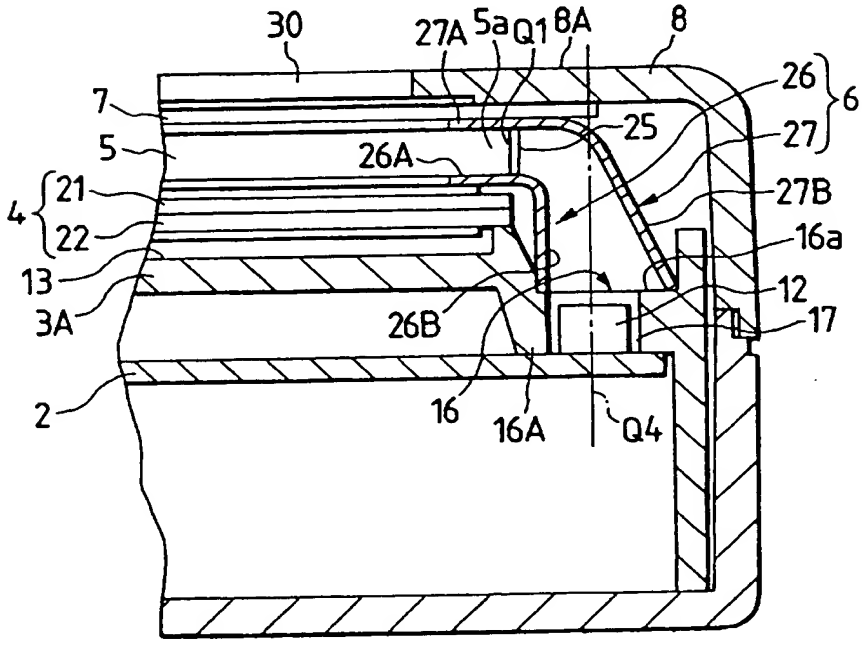

30
27A
5a
Q1
8A
8
26
6
7
25
27
5
26A
4
21
27B
22
16a
13
12
3A
26B
17
2
16
16A
Q4

FIG. 2

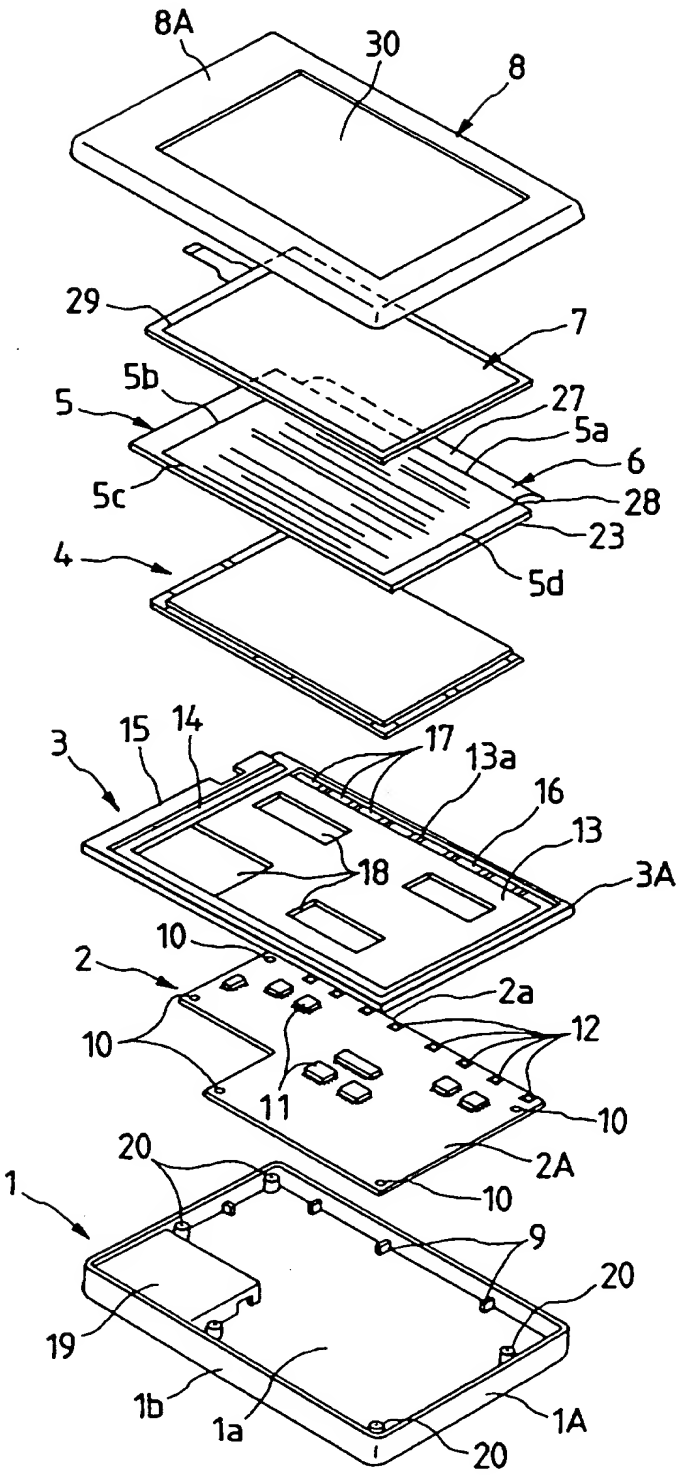


FIG. 4

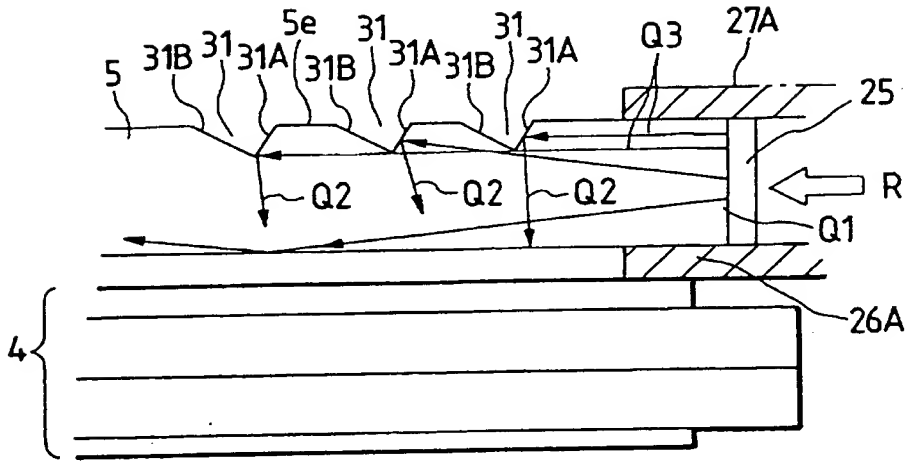

5
31B
31
31A
5e
31B
31
31A
31B
31
31A
Q3
27A
25
R
Q2
Q2
Q2
Q1
26A
4

FIG. 5

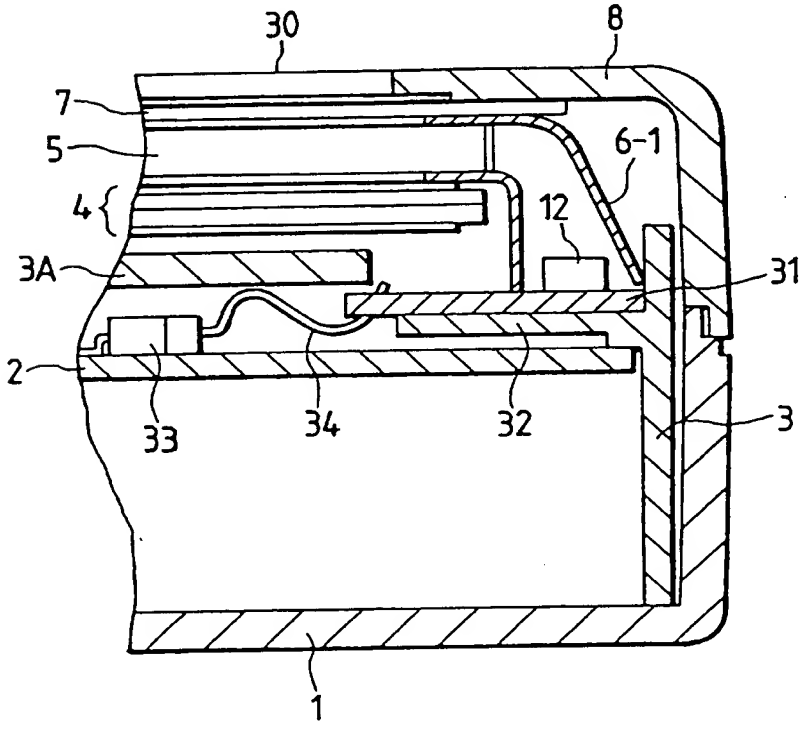
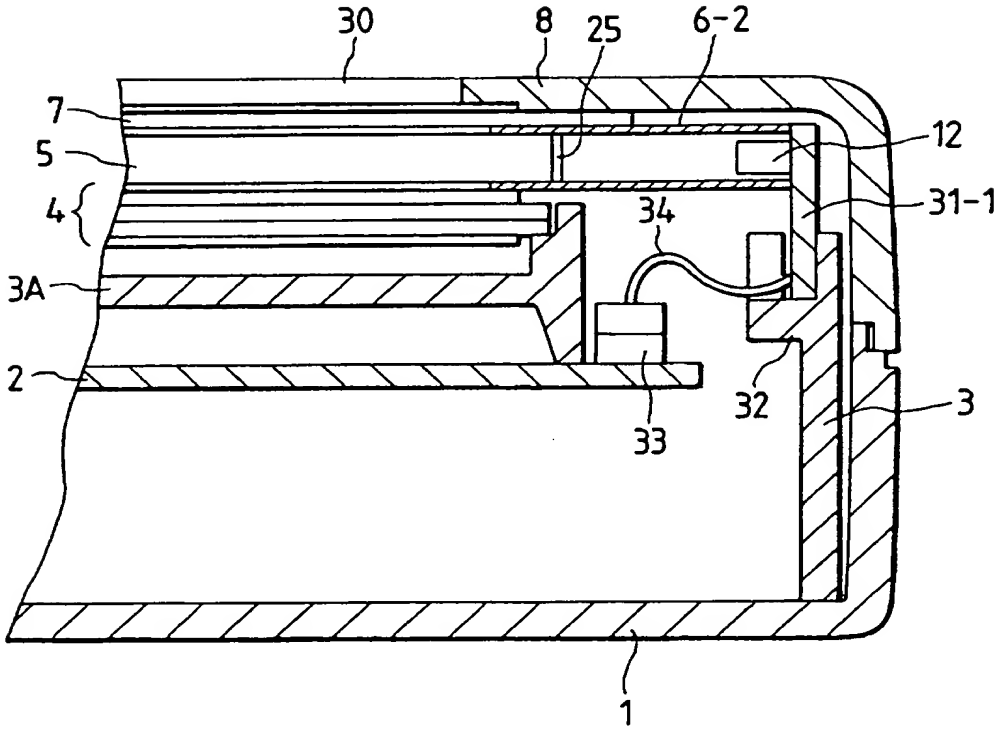

30
8
7
5
6-1
4
12
3A
31
2
33
34
32
3
1

FIG. 6



PORTABLE ELECTRONIC APPARATUS HAVING LIQUID CRYSTAL DISPLAY DEVICE

This invention relates to a portable electronic apparatus having a liquid crystal display (LCD) device.

Some portable electronic apparatuses such as portable computers and portable communication terminal apparatuses have liquid crystal display (LCD) devices. In general, LCD devices are of the transmission type, the semi-transmission type, and the reflection type.

A typical LCD device of the transmission type includes a backlight for illuminating a screen. The backlight uses, for example, a cold-cathode tube. The typical LCD device of the transmission type tends to be high in electric power consumption rate since the backlight is provided.

A known LCD device of the semi-transmission type includes a backlight using an EL (electroluminescence) surface illuminant. The EL surface illuminant tends to be short in life. The known LCD device of the semi-transmission type tends to be low in contrast between an indicated character and a base.

A general LCD device of the reflection type is low in electric power consumption rate. The general LCD device of the reflection type provides a high contrast between an indicated character and a

base. The general LCD device of the reflection type is useless in a dark place.

It is an aim of this invention to provide an improved portable electronic apparatus having a liquid crystal display (LCD) device.

A first aspect of this invention provides a portable electronic apparatus comprising a liquid crystal panel of a reflection type; a light guide member for guiding light to the liquid crystal panel; a light source for emitting light; means for guiding the light emitted by the light source to the light guide member; and a transparent plate-shaped member for covering the light guide member.

A second aspect of this invention is based on the first aspect thereof, and provides a portable electronic apparatus wherein the transparent plate-shaped member comprises a touch panel.

A third aspect of this invention is based on the first aspect thereof, and provides a portable electronic apparatus wherein the light source comprises a light emitting diode, and the means comprises a diffusion sheet adjoining a light input portion of the light guide member and a reflector for guiding the light emitted by the light source to the diffusion sheet.

A fourth aspect of this invention is based on the second aspect thereof, and provides a portable electronic apparatus wherein the light guide member comprises an acrylic-resin plate having a predetermined stiffness, the acrylic-resin plate having a reflection surface for reflecting incident light toward the liquid crystal panel,

the touch panel comprising an upper electrode and a lower electrode formed by films.

A fifth aspect of this invention is based on the third aspect thereof, and provides a portable electronic apparatus further comprising a circuit board for holding the light emitting diode, the reflector being curved, the circuit board and the light input portion of the light guide member being nonparallel to each other.

A sixth aspect of this invention is based on the fifth aspect thereof, and provides a portable electronic apparatus wherein the circuit board comprises a main circuit board for holding electronic parts.

A seventh aspect of this invention is based on the third aspect thereof, and provides a portable electronic apparatus further comprising means, provided around the light emitting diode, for reflecting return light back into the reflector.

An eighth aspect of this invention provides a portable electronic apparatus comprising a liquid crystal panel of a reflection type; a transparent member extending above the liquid crystal panel; a light source for emitting light; and first means for guiding the light emitted by the light source to an edge of the transparent member; wherein the transparent member comprises second means for reflecting the light guided by the first means toward the liquid crystal panel.

A ninth aspect of this invention is based on the eighth aspect thereof, and provides a portable electronic apparatus wherein the light source comprises a light emitting diode.

A tenth aspect of this invention is based on the eighth aspect thereof, and provides a portable electronic apparatus wherein the first means comprises a light guide member having an inner space and inner reflection surfaces, the light guide member extending between the light source and the edge of the transparent member, the light source extending in the inner space of the light guide member.

An eleventh aspect of this invention is based on the tenth aspect thereof, and provides a portable electronic apparatus wherein the light guide member is curved.

A twelfth aspect of this invention is based on the eighth aspect thereof, and provides a portable electronic apparatus wherein the first means comprises a diffusion sheet adjoining the edge of the transparent member.

A thirteenth aspect of this invention is based on the eighth aspect thereof, and provides a portable electronic apparatus wherein the transparent member has grooves defined by inclined surfaces which form the second means.

The present invention will be described further below with reference to exemplary embodiments and the accompanying drawings, in which:

Fig. 1 is a sectional view of a portion of a background-art portable electronic apparatus.

Fig. 2 is an exploded perspective view of a portable electronic apparatus according to a first embodiment of this invention.

Fig. 3 is a sectional view of a portion of the portable electronic apparatus in Fig. 2.

Fig. 4 is a sectional view of a light guide member and a light

inputting and reflecting portion in the portable electronic apparatus in Fig. 2.

Fig. 5 is a sectional view of a portion of a portable electronic apparatus according to a second embodiment of this invention.

Fig. 6 is a sectional view of a portion of a portable electronic apparatus according to a third embodiment of this invention.

A background-art portable electronic apparatus will be explained below for a better understanding of this invention.

Fig. 1 shows a portion of a background-art portable electronic apparatus having a liquid crystal display (LCD) device of the semi-transmission type. It is believed that the background-art apparatus of Fig. 1 is not prior art to this invention.

The background-art apparatus of Fig. 1 includes a casing composed of a lower member 41 and an upper member 48.

A circuit board 42 is located in the lower casing member 41. A liquid crystal panel holder 43 is placed in the casing. The liquid crystal panel holder 43 is fixed to bottom walls of the lower casing member 41. A major portion of the liquid crystal panel holder 43 extends above the circuit board 42. A surface illuminant 44 and a liquid crystal panel 45 are successively superposed on the liquid crystal panel holder 43. The surface illuminant 44 serves as a backlight for the liquid crystal panel 45. The surface illuminant 44 uses an EL (electroluminescence) member. The liquid crystal panel 45 is of a semi-transmission type. The surface illuminant 44 and the liquid crystal panel 45 compose an LCD device of the semi-

transmission type. A touch panel 47 is placed on the liquid crystal panel 45 via spacers 46. The touch panel 47 extends below top walls of the upper casing member 48.

When the lower casing member 41 and the upper casing member 48 are firmly connected to each other, the liquid crystal panel holder 43, the surface illuminant 44, the liquid crystal panel 45, and the touch panel 47 are held between the bottom walls of the lower casing member 41 and the top walls of the upper casing member 48.

When the apparatus is used in a dark place, the surface illuminant 44 is activated. When the apparatus is used in a bright place, the surface illuminant 44 is deactivated to save electric power.

The background-art apparatus of Fig. 1 has the following drawbacks. The EL surface illuminant 44 tends to be short in life. The LCD device of the semi-transmission type tends to be low in contrast between an indicated character and a base.

First Embodiment

Figs. 2, 3, and 4 show a portable electronic apparatus according to a first embodiment of this invention. The apparatus of Figs. 2, 3, and 4 includes a casing composed of a lower member 1 and an upper member 8. A main circuit board 2, a liquid crystal panel holder 3, a liquid crystal panel 4, a light guide member 5, a reflector (a light guide member) 6, and a touch panel 7 are disposed in the casing. The liquid crystal panel 4 is of a reflection type. The touch panel 7 includes a transparent plate-like member. The lower

casing member 1 and the upper casing member 8 form a main body of the apparatus.

The lower casing member 1 includes a main casing body 1A. The main casing body 1A has a rectangular bottom portion 1a, and a side wall portion 1b provided along edges of the bottom portion 1a. The side wall portion 1b extends upward from the edges of the bottom portion 1a. The main casing body 1A has a rectangular recess, one corner of which is occupied by a battery accommodating portion 19. The bottom portion 1a of the main casing body 1A has connection bosses 20. The connection bosses 20 have threaded holes respectively. Three of the connection bosses 20 extend at three other corners of the recess in the main casing body 1A, respectively. Two of the connection bosses 20 extend near the battery accommodating portion 19. The bottom portion 1a of the main casing body 1A has a plurality of spacers 9 arranged at predetermined intervals along the edges and extending near the side wall portion 1b. The spacers 9 form ribs extending between the bottom portion 1a and the side wall portion 1b.

The main circuit board 2 includes a main board body 2A having a shape similar to the shape of the recess in the main casing body 1A except the battery accommodating portion 19. The main board body 2A has corners formed with connection holes 10 respectively. The connection holes 10 positionally correspond to the connection bosses 20 of the main casing body 1A, respectively. Electronic parts 11 are mounted on an upper surface of the main board body 2A. In addition, light emitting diodes (LED's) 12 are

mounted on the main board body 2A. The light emitting diodes 12 are arranged along one longer side or edge of the main board body 2A at predetermined intervals. The light emitting diodes 12 are used as light sources respectively.

The liquid crystal panel holder 3 includes a main holder body 3A. The main holder body 3A includes a rectangular planar member 13, a panel support portion 14, and a frame portion 15. The panel support portion 14 and the frame portion 15 are provided along edges of the planar member 13. The panel support portion 14 and the frame portion 15 are connected to the planar member 13. The frame portion 15 extends outward of the panel support portion 14. The panel support portion 14 extend upward from the planar member 13. One longer side (edge) of the planar member 13 is provided with a reflector mounting portion 16. The reflector mounting portion 16 extends at a height position which is lower than a major upper surface of the planar member 13. The reflector mounting portion 16 has windows 17 for the respective light sources 12. The windows 17 positionally correspond to the light sources 12 respectively. The windows 17 are spaced at predetermined intervals along the longer side (edge) of the planar member 13. The planar member 13 has a plurality of openings 18.

As previously indicated, the liquid crystal panel 4 is of the reflection type. The liquid crystal panel 14 includes glass plates 21 and 22 extending parallel to each other. The liquid crystal panel 14 also includes opposed electrode plates provided on opposing sides of the glass plates 21 and 22. A space or a gap between the opposed

electrode plates is filled with liquid crystal.

The light guide member 5 includes a transparent plate made of acrylic resin. The acrylic resin plate has a thickness in the range of 1 to 2 mm. Thus, the acrylic resin plate has a predetermined stiffness. The acrylic resin plate has a rectangular shape. An upper surface 5e of the light guide member (the acrylic resin plate) 5 is formed with a plurality of grooves 31 extending parallel to a longer side (edge) thereof. Each of the grooves 31 has a V-shaped cross section. The grooves 31 are spaced along a direction parallel to a shorter side (edge) of the light guide member 5.

As best shown in Figs. 3 and 4, one longer side or one longer edge 5a of the light guide member 5 forms a light input portion (a light incident portion) Q1. As shown in Fig. 4, each of the grooves 31 is defined by inclined surfaces 31A and 31B which are closer to and remote from the light input portion Q1 respectively. The surfaces 31A of the respective grooves 31 form reflection surfaces which operate as follows. The reflection surfaces 31A are exposed to portions Q3 of beams of incident light which comes through the light input portion Q1. The reflection surfaces 31A reflect the portions Q3 of the incident light beams toward the liquid crystal panel 4. The reflection-resultant light beams travel from the reflection surfaces 31A along directions Q2 which form approximately right angles with respect to the direction of the travel of the incident light beams.

As best shown in Fig. 2, the light guide member 5 has shorter sides (edges) 5b and 5d, and a longer side (edge) 5c in addition to

the previously-indicated longer side (edge) 5a. The light guide member 5 is provided with a frame portion 23 extending along the edges 5b, 5c, and 5d. As shown in Figs. 3 and 4, a diffusion sheet (a diffuser) 25 is attached to an end surface of the longer side or edge 5a of the light guide member 5. In addition, the reflector 6 is connected to the longer side or edge 5a of the light guide member 5.

The reflector (the light guide member) 6 includes an inner reflection plate 26, an outer reflection plate 27, and two end reflection plates 28. The reflector 6 has an inner space defined by the inner reflection plate 26, the outer reflection plate 27, and the two end reflection plates 28. The inner reflection plate 26, the outer reflection plate 27, and the two end reflection plates 28 have inner reflection surfaces exposed in the inner space of the reflector 6. The inner reflection plate 26 has a connecting portion 26A and a reflection surface portion 26B. The reflection surface portion 26B extends from the connecting portion 26A at an approximately right angle. The outer reflection plate 27 has a connecting portion 27A and a reflection surface portion 27B. The reflection surface portion 27B extends from the connecting portion 27A at an obtuse angle. The inner reflection plate 26 and the outer reflection plate 27 are connected to each other via the end reflection plates 28 in a manner such that the connecting portions 26A and 27A are parallel to and spaced from each other.

The longer side or edge 5a of the light guide member 5 is inserted into the region between the connecting portions 26A and

27A of the reflector 6. Thereby, the reflector 6 is connected to the light guide member 5.

The touch panel 7 has a frame portion 29 extending along edges thereof. The upper casing member 8 has a top wall portion or a top planar portion 8A formed with a rectangular opening window 30. Upper and lower electrodes (not shown) on the touch panel 7 are formed by films.

The main circuit board 2 is located in the lower casing member 1. The main circuit board 12 is fixed to the lower casing member 1 by screws (not shown) extending into the threaded holes of the bosses 20 via the connection holes 10. The spacers 9 support edge portions of the main circuit board 2. As previously indicated, the liquid crystal panel holder 3 is located in the apparatus casing. A major portion of the liquid crystal panel holder 3 is placed on the main circuit board 2. The frame portion 15 of the liquid crystal panel holder 3 has a downward projection reaching the bottom walls of the lower casing member 1. Thus, the liquid crystal panel holder 3 is supported also by the bottom walls of the lower casing member 1. As previously indicated, the liquid crystal panel holder 3 has the reflector mounting portion 16. Lower surfaces 16A of the reflector mounting portion 16 contact the upper surface of the main circuit board 2. The light emitting diodes 12 on the main circuit board 2 extend into the respective windows 17 of the reflector mounting portion 16. The electronic parts 11 on the main circuit board 2 extend into the openings 18 in the planar member 13 of the liquid crystal panel holder 3.

The liquid crystal panel 4 is placed on the panel support portion 14 of the liquid crystal panel holder 3. The light guide member 5 is superposed on the liquid crystal panel 4. The reflector 6 is connected to the light guide member 5. A lower portion of the reflector 6 is inserted into the reflector mounting portion 16 of the liquid crystal panel holder 3. Lower edges of the reflector 6 contact surfaces of the reflector mounting portion 16. The reflector 6 is supported by the reflector mounting portion 16 of the liquid crystal panel holder 3. The touch panel 7 is superposed on the light guide member 5. The top wall portion 8A of the upper casing member 8 extends adjacently above the touch panel 7. When the lower casing member 1 and the upper casing member 8 are firmly connected to each other, the liquid crystal panel holder 3, the liquid crystal panel 4, the light guide member 5, and the touch panel 7 are held between the bottom walls of the lower casing member 1 and the top walls of the upper casing member 8.

In Fig. 3, the character Q4 denotes the optical axes of the light emitting diodes (LED's) 12. The light guide member 5 extends along a plane perpendicular to the optical axes Q4 of the LED's 12. The LED's 12 emit light beams into the reflector 6. The emitted light beams R travel to the longer edge 5a of the light guide member 5, that is, the light input portion Q1 thereof while being reflected and guided by the reflector 6.

The upper surfaces 16a of the reflector mounting portion 16 of the liquid crystal panel holder 3 have light reflecting films such as white coats or printed white films. In addition, the inner

circumferential surfaces of the walls of the reflector mounting portion 16 which define the windows 17 for the respective light sources 12 have light reflecting films such as white coats or printed white films.

The light emitting diodes (LED's) 12 are turned on and off by suitable drive circuits mounted on the main circuit board 2. The LED's 12 emit light beams R when being turned on. The light beams R enter the reflector 6. The light beams R are propagated to the diffusion sheet 25 on the longer edge 5a of the light guide member 5 while being reflected and guided by the inner reflection plate 26, the outer reflection plate 27, and the two end reflection plates 28 of the reflector 6. The light beams R passes through the diffusion sheet 25 while being diffused thereby. The diffusion-resultant light beams are incident to the longer edge 5a of the light guide member 5, that is, the light input portion Q1 thereof. Then, the diffusion-resultant light beams are propagated in the light guide member 5.

As understood from the above explanation, the reflector 6 operates as a light guide member for guiding light from the LED's 12 to the light guide member 5. To implement this operation, inner surfaces of the reflector 6 may have mirrors.

As shown in Fig. 4, portions Q3 of the incident light beams (the diffusion-resultant light beams) encounter the reflection surfaces 31A in the grooves 31, being reflected thereby toward the liquid crystal panel 4. The reflection-resultant light beams are incident to the liquid crystal panel 4 at approximately right angles.

Thus, the liquid crystal panel 4 is illuminated by the light beams generated by the LED's 12.

In general, the LED's 12 are turned on when the apparatus is used in a dark place. In this case, since the liquid crystal panel 4 is illuminated by the light beams generated by the LED's 12, the contents of information indicated by the liquid crystal panel 4 can be seen. In general, the LED's 12 are turned off when the apparatus is used in a bright place. In this case, electric power economy is provided.

The plural LED's 12 and the diffusion sheet 25 operate to apply an uniform light beam to the light guide member 5. The LED's 12 are inexpensive, and are small in size. Furthermore, the LED's 12 are long in life.

The touch panel 7 extends above the light guide member 5. The touch panel 7 protects the grooves 31 in the light guide member 5 so that the optical performance of the light guide member 5 can be maintained for a long time.

The light guide member 5 uses the acrylic resin plate having a thickness in the range of 1 to 2 mm. Thus, the light guide member 5 is stiff enough to keep its original shape even when a certain force is applied thereto from above. Accordingly, in the case where a normal depression force is applied to the touch panel 7, the light guide member 5 blocks the transmission of the force to the liquid crystal panel 4. Thus, the light guide member 5 protects the liquid crystal panel 4.

As previously indicated, the upper and lower electrodes on

the touch panel 7 are formed by the films. Thus, the touch panel 7 can be thin. The thin touch panel 7 is effective in reducing a parallax (an undesired depth-related visual sensation) concerning information indicated on the liquid crystal panel 4.

As previously mentioned, the light guide member 5 extends along the plane perpendicular to the optical axes Q4 of the light emitting diodes (LED's) 12. The reflector 6 is angled or curved to guide the light beams R from the LED's 12 to the longer edge 5a of the light guide member 5, that is, the light input portion Q1 thereof. The angled or curved design of the reflector 6 enables a smaller horizontal dimension of the apparatus.

As previously indicated, the upper surfaces 16a of the reflector mounting portion 16 of the liquid crystal panel holder 3 have the light reflecting films such as the white coats or the printed white films. In addition, the inner circumferential surfaces of the walls of the reflector mounting portion 16 which define the windows 17 for the respective light sources 12 have the light reflecting films such as the white coats or the printed white films. These light reflecting films return backwardly reflected light toward the light guide member 5 so that the light beams emitted from the light sources 12 can be efficiently used in illuminating the liquid crystal panel 4.

The light emitting diodes (LED's) 12 and their drive circuits are mounted on the main circuit board 2. Accordingly, it is unnecessary to provide another circuit board for mounting the LED's 12. In addition, it is unnecessary to provide cables and connectors

for electric connection between the LED's 12 and their drive circuits. Thus, it is possible to reduce the cost and the size of the apparatus.

Second Embodiment

Fig. 5 shows a second embodiment of this invention which is similar to the first embodiment thereof except for design changes indicated later.

As shown in Fig. 5, the second embodiment of this invention includes an LED circuit board 31 on which LED's 12 are mounted. The LED circuit board 31 is separate from a main circuit board 2.

In the embodiment of Fig. 5, a liquid crystal panel holder 3 is formed with a board hold portion 32. The LED circuit board 31 is supported on the board hold portion 32. The LED circuit board 31 extends parallel to the main circuit board 2. The LED circuit board 31 and the main circuit board 2 are electrically connected via a connector 33 and a cable 34.

In the embodiment of Fig. 5, a reflector 6-1 is provided in place of the reflector 6 (see Figs. 2 and 3). Basically, the reflector 6-1 is similar in structure to the reflector 6. A lower portion of the reflector 6-1 contacts an upper surface of the LED circuit board 31. The LED's 12 extend into the reflector 6-1. Thus, the LED's are placed in the reflector 6-1. The reflector 6-1 is supported by the LED circuit board 31 and the liquid crystal panel holder 3.

Third Embodiment

Fig. 6 shows a third embodiment of this invention which is similar to the first embodiment thereof except for design changes

indicated later.

As shown in Fig. 6, the third embodiment of this invention includes an LED circuit board 31-1 on which LED's 12 are mounted. The LED circuit board 31-1 is separate from a main circuit board 2.

In the embodiment of Fig. 6, a liquid crystal panel holder 3 is formed with a board hold portion 32. The LED circuit board 31-1 is supported by the board hold portion 32. The LED circuit board 31-1 extends perpendicular to the main circuit board 2. The LED circuit board 31-1 and the main circuit board 2 are electrically connected via a connector 33 and a cable 34.

In the embodiment of Fig. 6, a reflector 6-2 is provided in place of the reflector 6 (see Figs. 2 and 3). The reflector 6-2 has an uncurved shape. The reflector 6-2 extends horizontally. In Fig. 6, right-hand edges of the reflector 6-2 contact a left-hand surface of the LED circuit board 31-1. The LED's 12 extend into the reflector 6-2. Thus, the LED's 12 are placed in the reflector 6-2.

CLAIMS

1. A portable electronic apparatus comprising:

a liquid crystal panel of a reflection type;

a light guide member for guiding light to the liquid crystal panel;

a light source for emitting light;

means for guiding the light emitted by the light source to the light guide member; and

a transparent plate-shaped member for covering the light guide member.

2. A portable electronic apparatus according to claim 1, wherein the transparent plate-shaped member comprises a touch panel.

3. A portable electronic apparatus as recited in claim 2, wherein the light guide member comprises an acrylic-resin plate having a predetermined stiffness, the acrylic-resin plate having a reflection surface for reflecting incident light toward the liquid crystal panel, the touch panel comprising an upper electrode and a lower electrode formed by films.

4. A portable electronic apparatus according to claim 1, 2 or 3, wherein the light source comprises a light emitting diode, and the means comprises a diffusion sheet adjoining a light input portion of the light guide member and a reflector for guiding the light emitted by the light source to the diffusion sheet.

5. A portable electronic apparatus according to claim 4, further comprising a circuit board for holding the light emitting diode, the reflector being curved, the circuit board and the light input portion of the light guide member being nonparallel to each other.

6. A portable electronic apparatus according to claim 5, wherein the circuit board comprises a main circuit board for holding electronic parts.

7. A portable electronic apparatus according to claim 4, 5, or 6, further comprising means, provided around the light emitting diode, for reflecting return light back into the reflector.

8. A portable electronic apparatus comprising:

a liquid crystal panel of a reflection type;

a transparent member extending above the liquid crystal panel;

a light source for emitting light; and

first means for guiding the light emitted by the light source to an edge of the transparent member;

wherein the transparent member comprises second means for reflecting the light guided by the first means toward the liquid crystal panel.

9. A portable electronic apparatus according to claim 8, wherein the light source comprises a light emitting diode.

10. A portable electronic apparatus according to claim 8 or 9, wherein the first means comprises a light guide member having an inner space and inner reflection surfaces, the light guide member extending between the light source and the edge of the transparent member, the light source extending in the inner space of the light guide member.

11. A portable electronic apparatus according to claim 10, wherein the light guide member is curved.

12. A portable electronic apparatus according to any one of claims 8 to 11, wherein the first means comprises a diffusion sheet adjoining the edge of the transparent member.

13. A portable electronic apparatus according to any one of claims 8 to 12, wherein the transparent member having grooves defined by inclined surfaces which form the second means.

14. A portable electronic apparatus constructed and arranged to operate substantially as hereinbefore described with reference to Figures 2 to 6 of the accompanying drawings.

Application No: GB 9910125.5
Claims searched: All

Examiner: Matthew Lincoln
Date of search: 26 July 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G5C (CHX)

Int Cl (Ed.6): G02F 1/1335

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, P	EP 0867747 A2	(SONY) Figure 1, abstract	X: 1, 4 to 9, 12, 13
X, Y	EP 0107757 A1	(BOSCH) Figures 1 and 3, abstract.	X: 1, 4 to 12 Y: 2, 3
X, Y	EP 0056843 A2	(SIEMENS) Figure, abstract	X: 1, 4 to 9, 12 Y: 2, 3
X, P	JP 100326515 A	(SHARP) See figure 12 and PAJ Vol. 099 No. 331	1, 4 to 9, 12
X, P	JP 100268307 A	(SHARP) See figure 1 and PAJ Vol 099 No. 129	1, 4 to 9, 12
X, Y	US 5608550	(EPSTEIN) Figure 4A, column 3 lines 37 to 40 and lines 47 to 59	X: 1, 4 to 9, 12
X, Y	US 4212048	(CASTLEBERRY) Figure 3	X: 1, 4 to 9, 12
Y	WO97/48107	(SUMITOMO OSAKA CEMENT) Abstract	2, 3

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art.
Y Document indicating lack of inventive step if combined with one or more other documents of same category.	P Document published on or after the declared priority date but before the filing date of this invention.
& Member of the same patent family	E Patent document published on or after, but with priority date earlier than, the filing date of this application.

FIG. 1

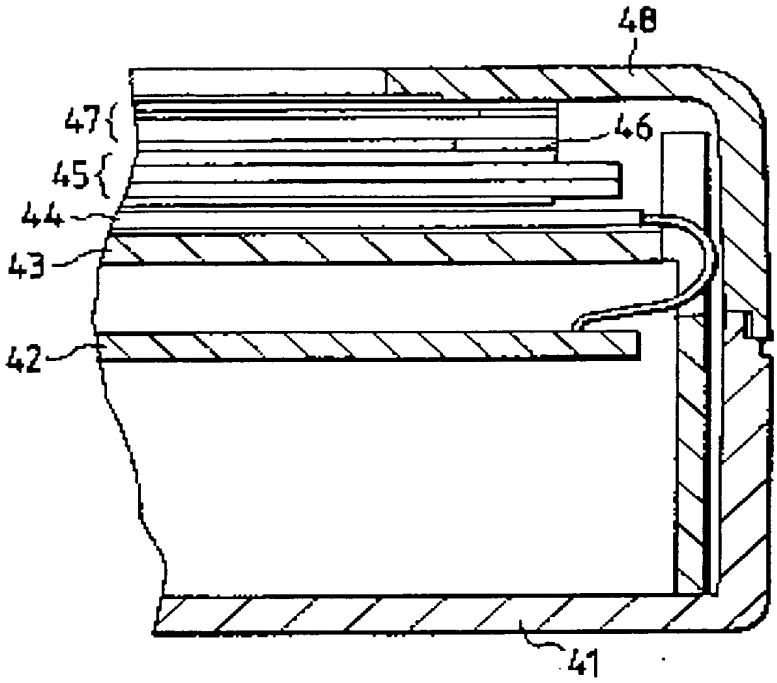


FIG. 3

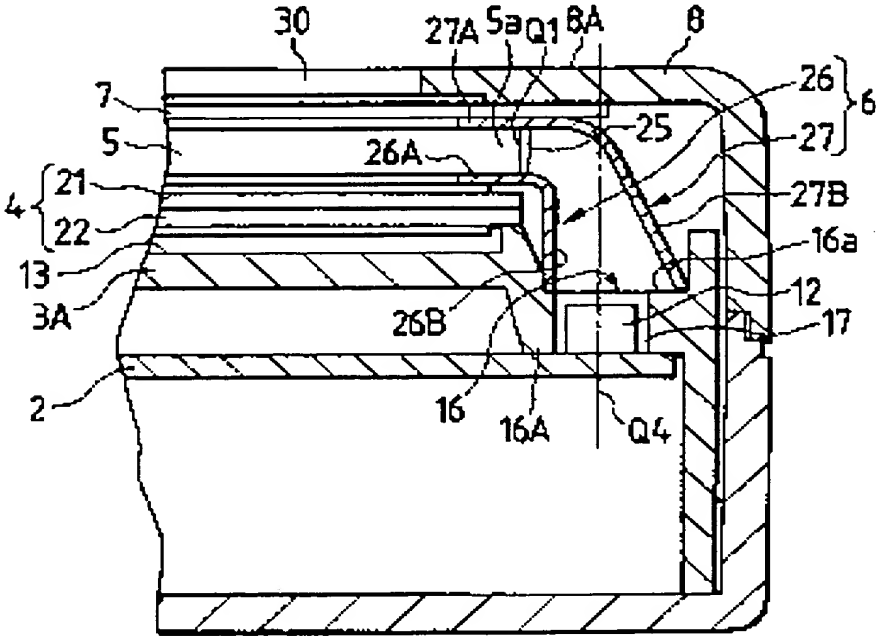


FIG. 2

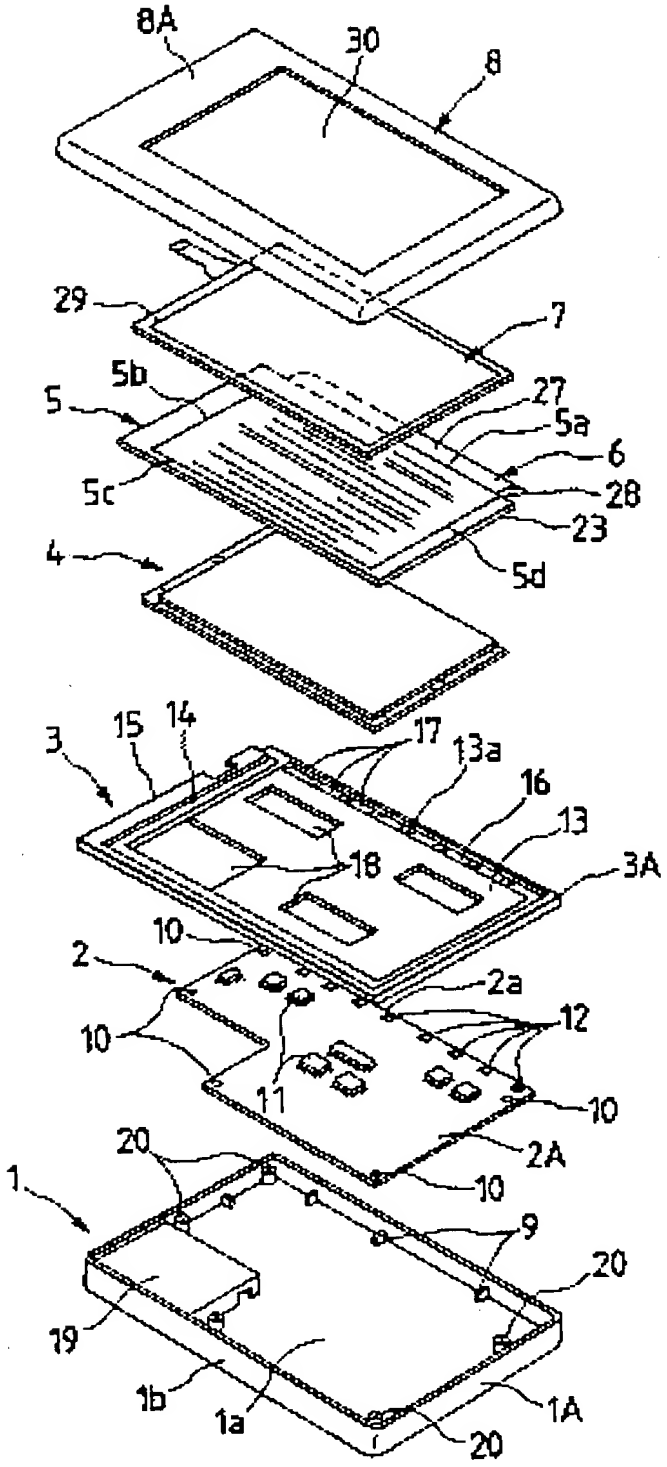

8A
30
8
29
7
5b
5
27
5a
6
5c
28
23
5d
4
3
15
14
17
13a
16
13
18
3A
10
2
2a
12
10
11
10
2A
10
20
1
9
20
19
1b
1a
1A
20

FIG. 4

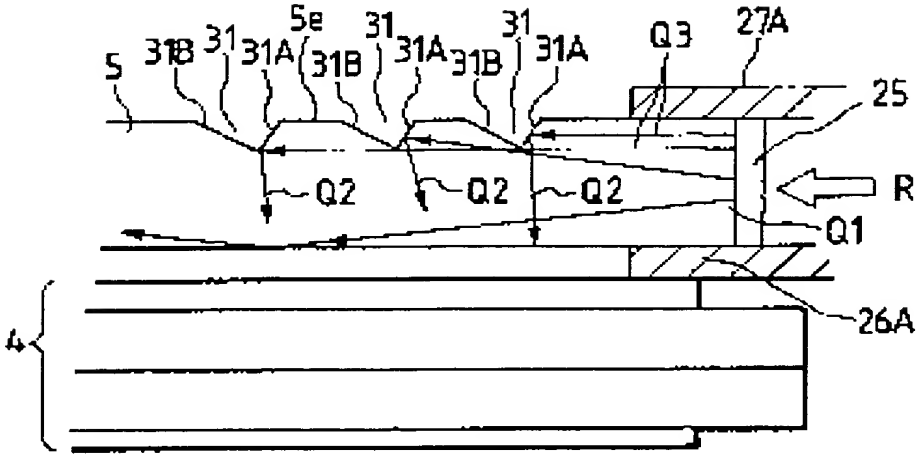


FIG. 5

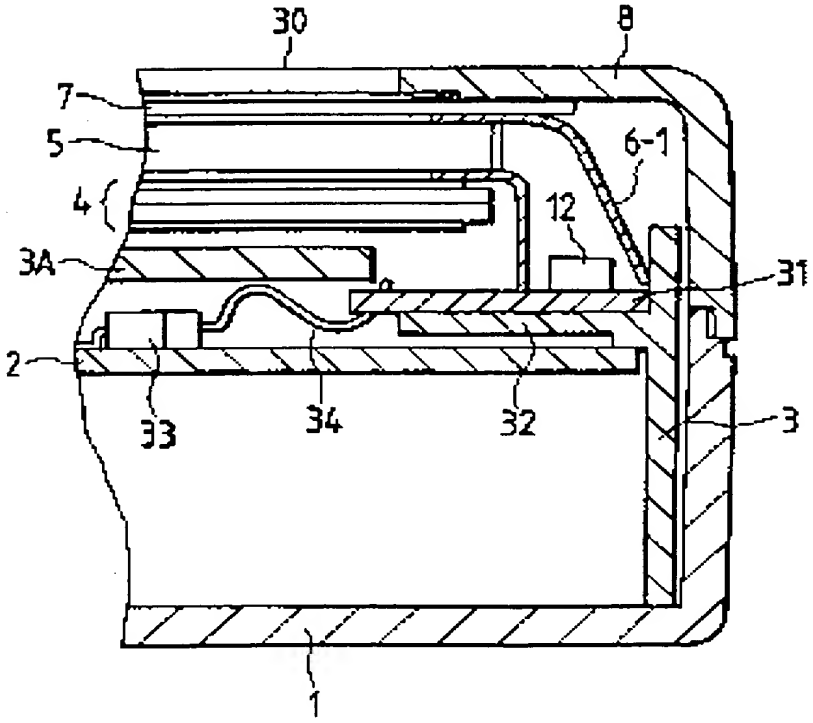


FIG. 6